A Flood Resilience Policy Analysis:

New York City

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Introduction

The urgency of flood resilience in coastal regions has amplified over the past decade as several high cost storms have hit significant metropolitan regions. New data has indicated that major hydrological events have doubled since 2004 and quadrupled since 1984 (EASAC 2018). The Mid-Atlantic United States is particularly vulnerable to coastal flooding as the statistics approximate above average sea level rise for the region (EPA, 16). Sea levels are expected to rise globally between eight inches and six and a half feet by the end of the century (NYC Special Initiative for Rebuilding and Resiliency 2013). The Mid-Atlantic region SLR rates are three to four times the global average, indicating a much faster rate of increase than other parts of the globe. This region encompasses several densely populated areas including New York City. Strategies to mitigate climate change impacts or adapt to changing environmental conditions have become frontline topics in planning and urban design.

New York City consists of five boroughs encompassing 578 miles of coastline have become testing labs for flood resilient design. (RF, Atlantic, 12). Roughly eight and a half million people populate the five boroughs with a population density of over 27,000 people per square mile making it the most densely populated city in the United States. Queens County, NY consisting of the borough of Queens has an estimated population of two million people and 20,000 people per square mile (ACS, New York City, New York 2018). Queens is a borough part of Long Island located across the east river and is vulnerable to coastal flooding. Most recently the New York City Metro region experienced extreme flooding during Hurricane Sandy, a category one hurricane. The flooding was extensive, the NYC Department of Buildings determined 800 buildings to be structurally unsound or destroyed, mainly due to storm surge flooding (City of New York, 13). The City of New York was prompted to implement various planning and development changes including a Flood Resilience Text Amendment. This zoning amendment was a temporary solution to meet new FEMA standards. The permanent amendment is still pending following a review of the shortcomings in the temporary amendment and a robust community engagement process.

Purpose

Prior to the Hurricane Sandy, FEMA had been preparing flood map changes, which were then released as Preliminary Flood Insurance Rate Maps for the City of New York in 2013. The last

significant update to the city's flood maps was in 1983. Furthermore, the National Flood Insurance Program have demanded properties to meet new standards of flood resilience. Industry leaders are striving to answer several questions including: How can we ensure that buildings meet these higher flood protection standards while preserving the vitality of our neighborhoods (Burden, 13), and how well are we measuring, evaluating and implementing policy for flood resilience? The purpose of this paper is to show an evaluative process determining a policy's flood resilience level based on established best practices and a fair grading criterion. This paper delivers a process outline for future evaluative studies helping cities understand how they can better prepare for more frequent and severe floods.

This evaluative policy analysis hypothesizes that current New York City regulations, plans and design standards are meaningfully reflective of established best practices in flood resilience. The results of the analysis will render flood resilient best practices established in theory and practice to be objectively present in the planning and design regulations and initiatives in Queens, New York. Policies and initiatives will be assessed further based on a subjective criterion created through the research. These results would benefit city planners, developers, designers, and political officials by separating the best practices encouraged by existing plans, outlining methods for improvement and showing established practices absent to existing plans and regulations. This will allow city planners and political officials to focus on implementing best practices absent in current regulations and support those which are reinforced by regulations. This paper will highlight areas of flood resilient regulation in planning and design while providing policy recommendations for planners and political officials in New York City.

Structure

First, this paper will review established planning and design Best Practices (BP's) for flood resilience. An analysis of flood resilient BP's are extracted and compared with development standards, planning initiatives and design guidelines in New York City and Queens. The research goal is to match best practices found in the established planning and design literature with the community planning initiatives, design guidelines and development standards in Queens, New York. The analysis will further determine how well the existing regulations are meeting established resilient design standards. Queens was chosen for this paper because of its

vulnerability to coastal flooding, urban qualities and recent flooding caused by severe hydrological events.

Literature Review (Best Practices Document Review)

The literature review organizes, asses and provide examples of theoretical and established best practices in flood resilient planning and design through a Best Practices Document Review. The review categorizes best practices through Zoning Site and Building Design and Urban Design. In figure 1 the best practice document review is visualized and outlined. The review analyzes Land Use controls and methods that enhance flood resilience and encourage flood resilient form. Furthermore, flood resilient best practices in urban design are examined through public spaces and site design methods. Cases are discussed where the best practices described have been most aptly implemented. The review will be followed by a discussion on the methods used to analyze intersections between best practices in flood resilience and policy and initiatives formulated and administered in NYC and Queens.

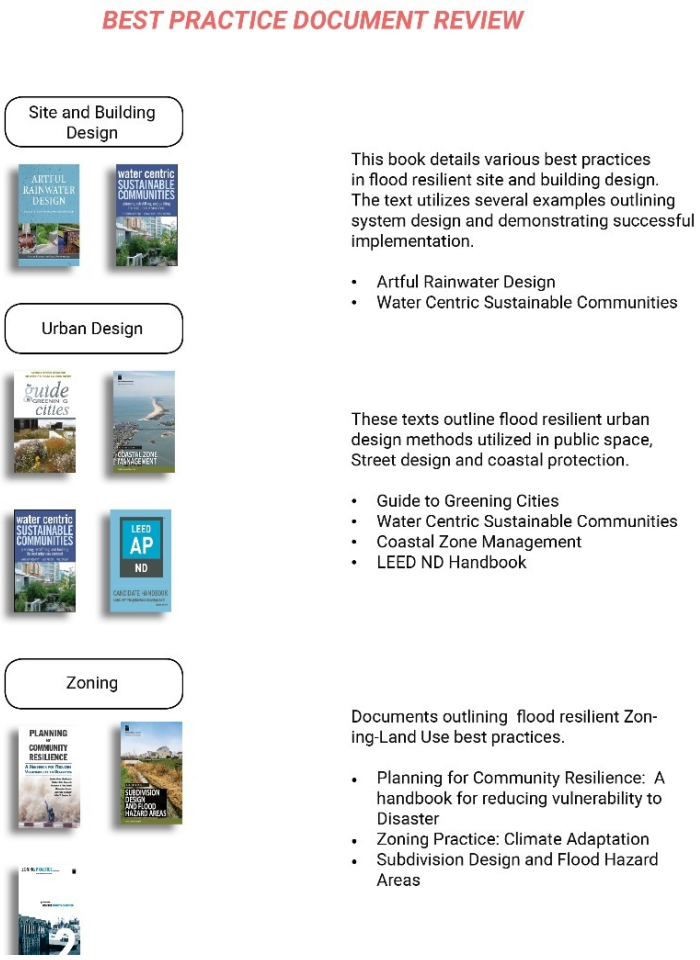

Figure 1

Best Practices: Resilient Zoning

Land use controls are essential tools planners and policymakers can use to shape urban form and development. Mitigating potential severe flooding in urban centers begins with discouraging development in areas prone to severe and frequent hydrological events. Land use can effectively reduce the impact of severe urban flooding by steering development away from lands prone to hydrological hazards, limiting developments impact on the land and preserving lands with an essential water related function within the ecological system. Ian McHarg, one of the originators of ecological design, discusses the coastal ecosystem and corresponding impacts from developments (Mcharg, 1969). McHarg elicits where construction is appropriate relative to the ecological functions of dunes, dikes and seagrass (Mcharg, 1969). Regulating the location of development is an underlying principle of land use laws. This section will examine emerging and current land use strategies which promote developments conforming to flood resilient urban form and design.

Residential Subdivision Ordinances

Residential Subdivision Ordinances underlies a local jurisdiction's legal authority to plan for public amenities and infrastructure. The subdivision of land into smaller parcels or lots for subsequent development or sale enables regulating authorities to have influence when planning infrastructure and amenities serving the land. Once the authority to regulate has been established, local jurisdictions may encourage or require flood resilient design practices for the infrastructure and amenities supporting the subdivisions. These may include green space, development clusters, street design standards, parks and public space. Residential subdivision ordinances are the most commonly utilized land use control which 75% of municipalities implement (Masterson, Peacock, Van Zandt, Grover, Schwarz and Cooper 2014).

Subdivision ordinances that integrate thoughtful planning and design practices with regulation are a powerful tool in flood hazard planning. Best practices in subdivision ordinances follow the principles listed below.

1. Maintain communication with stakeholder and community members throughout process facilitating coordination and buy in.

2. Apply multiple tools and techniques for structural and non-structural flood mitigation measures.
3. and allow for creativity in design and adopt a watershed scale approach to flood risk reduction where possible.
4. Design new infrastructure and adapt existing infrastructure, including stormwater facilities and transportation networks to be resilient to both high and low frequency flood events.
5. Protect open space and incorporate green infrastructure into development patterns.
6. Ensure that subdivision related development include provisions for enforcement personnel (PAS 584).

Augusta, Georgia successfully implemented a conservation subdivision ordinance intended to reduce flood risk. The ordinance requires lots of 20 acres or more to protect at least 40 percent of the overall acreage of the tract as greenspace or open space. Developers got on board because the ordinance allowed them to construct detached housing with lots that have no minimum lot size. Further benefits for developers include reducing costs through less needed infrastructure like roadway surfaces, water and sewer lines. Property values for surrounding homes soared due to their proximity to green and open space (PAS 584).

Planned Unit Developments

Planned Unit Developments are a type of zoning allowing for developers to be more flexible. These developments are typically on larger plots of land for which a master plan is proposed. Planned Unit Developments are master planned and typically follow compact form with higher densities. In terms of flood resilient developments, compact form provides benefits including preserving land through an efficient use of space. A planned unit development master plan will include mixed use retail and residential with varying densities. Developers are always looking to add density and planned unit developments enable flexibility for developers by promoting density bonus incentives. The density bonus allows developers to build more units than the existing zoning allows for in return for one or more items promoting the public good. In terms of flood resilience, the municipality could require, storm water systems incorporating green infrastructure and these systems would be above what the code requires. (Masterson, Peacock, Van Zandt, Grover, Schwarz and Cooper 2014))

The City of Norfolk Virginia is aiming to approve the most resilient zoning code in the country. The City created a Planned Development zoning district dedicated to Planned Unit Developments where the district adheres the flexibility and unique form of master planned neighborhoods. Norfolk has also implemented a resilience quotient in their development code requiring applicable development to go through additional site plan review process for resilience. Compliance under the resilience quotient is determined by city staff utilizing outside experts ensuring the new site meets the cities resilience goals. The new zoning code was approved in January of 2018.

Performance Based Zoning-Form Based Code

Traditional Euclidean zoning originated from the supreme court case Euclid V. Ambler Realty in 1926, which granted local jurisdictions the police power to regulate development ensuring public health and safety. This ruling led to zoning regulations intended to separate noxious and intense uses from less intense or noxious uses promoting less congestion. For most municipalities Euclidean zoning is currently maintained throughout the United States.

Alternative zoning methods have been introduced including “form-based codes” and “performance-based zoning”. The built environments born through these alternative methods are increasingly adaptable and preserve land essential to ecological systems, while also promoting diverse, compact urban environments. Performance based zoning establishes various physical and operational standards for new developments based on the set vision for the city. Performance-based standards supporting flood resilience require can require developments to implement impervious surface assessments, open space ratios and wetland protection plans in their final project. A performance-based district allows for a mixture of uses, by eliminating conventional zoning and promoting flexibility for developers. However, these developments must conform to the performance standards set for the district.

Similarly, form-based codes allow for flexibility of use and regulates development through prescriptive urban form encouraging walkable compact neighborhoods, mixed use districts and a high-quality public realm. Flood resilience is encouraged in all aspects by preserving space, encouraging several functions for varying spaces including mixed use developments and public spaces. The greater emphasis on public space allows for more governmental influence to

implement flood resilient design. Increase of mixed-use developments detract from additional car-oriented sprawl development preserving land from development.

The Miami 21 zoning ordinance was adopted in 2012 and was the first zoning code in a major

Figure 2

city to adopt a form-based zoning format. The code segments zones through transects of urban form, each transect zone has separate requirements maintaining its urban or rural character. In adopting form-based codes flood resilience is encouraged indirectly in regulating development by urban form. Figure 2 illustrates the transect zones of the built and non-built environment forming the basis of form-based code regulating through form rather than use.

Overlay Zoning

Overlay zoning consists of additional regulations superimposed on an existing zoning district. Overlay zoning districts are utilized in various circumstances, however its primary intention is to preserve the existing land from obtrusive high impact development. These additional regulations provide difficult obstacles for new developments on lands with overlays often requiring a limit to development that cannot support new profitable development. Overlay zoning is consistently used in historic districts preserving architectural character and in land conservation for resource preservation.

Hazard mitigation planning often utilizes overlay zoning to supplement regulations on areas vulnerable to hazards. Areas with a known propensity for experiencing certain natural conditions such as wildfires, landslides and flooding use overlay zoning to mitigate the impacts of these conditions on future development.

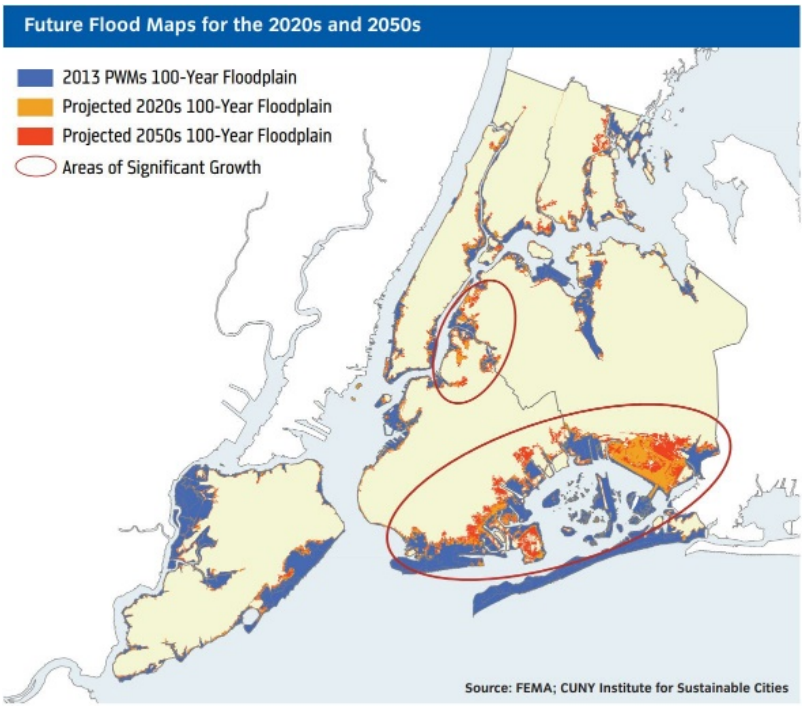

Figure 3

In considering flood resilience overlay zoning can play a significant role promoting flood resilient design as well as preventing further intrusive development in flood prone areas. (Masterson, Peacock, Van Zandt, Grover, Schwarz and Cooper 2014)

NYC implements overlay zoning in most of their vulnerable coastal neighborhoods. The supplemental zoning regulations seek an urban form and building design which defrays the impacts of expected flooding. Figure 3 illustrates the use of overlay zoning in using flood projections to identify areas most at risk which require supplemental regulations.

Best Practices: Site and Building Design

While land use is a promising tool adapting urban form to hazardous flood conditions, it is often superseded by development pressures. Areas designated as high hazard zones are typically in locations with high demand for development given their unique natural condition, recreational opportunities and limited availability. The incentive for developers to overcome land use barriers to capture demand for these markets becomes significant given the promising market factors. (Masterson, Peacock, Van Zandt, Grover, Schwarz and Cooper 2014))

Site Design

Site design for sustainable storm water has become central to planning and urban design as cites grow and impervious surfaces increase water velocity and first flush quantity. Methods for adapting to more water and less pervious surface for water to infiltrate will be a challenge. increased flood conditions through promoting low impact developments. Figure 4 displays key identifiers within the literature "Artful Rainwater Design" which utilizes five goals for achieving sustainable storm water management. The goals are condensed from various storm water best practice manuals and are listed below (Echols and Pennypacker 2015).

	Sustainable Storm Water Management Goals
Goal 1:	Reducing pollutant loads in rainwater
Goal 2:	Reduce downstream damage from runoff
Goal 3:	Safely move, control and contain rainwater
Goal 4:	Capture rainwater for reuse (of all kinds human and natural from irrigation to toilet flushing to groundwater recharge)
Goal 5:	Restore or create habitat.

Figure 4

The goals mentioned above are fulfilled through constructing low impact design utilizing storm water management techniques encompassing universally accepted objectives. The best practice objectives include conveyance (moving water), detention (water detention for offsite discharge), retention (capturing and holding water on site), infiltration (rain water recharging groundwater), filtration (reducing pollution in storm water runoff). The objectives are realized through various site design methods linked to multiple objectives. Some common methods are listed in the table below (Echols and Pennypacker 2015).

Site Design Method	Infrastructure	Space	Objectives
Bio Swale	Green	Private and Public	Conveyance, Filtration, Infiltration
Dry Detention Basin	Green	Public	Conveyance, Retention, Filtration
Flow Splitters	Gray	Private	Conveyance
Flow Through Filter Planter	Green	Private and public	Conveyance, Retention, Filtration, Infiltration

Infiltration Basin or Trench	Green	Public	Retention, Filtration, Infiltration
Rain Gardens	Green	Public	Retention, Filtration, Infiltration
Rainwater Harvesting Container	Gray	Private	Conveyance, Filtration
Rainwater Trails	Gray	Private	Conveyance, Detention, Filtration, Infiltration
Wet Detention Basin and Constructed Wetland	Green	Public	Conveyance, Retention, Filtration

Figure 5

The table in figure 5 the storm water management objectives are shown to be achieved through the design method as well as the type of infrastructure (gray or green) and the space (public or private) where each design method is most commonly utilized. It is important to distinguish how specific design methods are implemented because specific design barriers of private or public spaces influence the chosen methods. For example, if would be difficult to design a man-made wetland or detention basins on private lots. Most private lots, due to their small size, cannot handle the ecological functions of wetlands. Furthermore, private lots are typically not located in areas where wetlands or wet detention basins would function appropriately.

Public spaces tend to be larger and would typically utilize design methods requiring more open space to function, like green infrastructure. Most private lots are built out and are typically smaller lots contrasting from public spaces. Generally smaller spaces with structures warrant more grey infrastructure methods than green. However, some methods overlap in the space which they function best. Figure 5 shows the bio swale, flow through filter planter and flow splitters are design methods best applicable to both public and private space.

Building Design

Methods of flood resilient building design follow prescriptive strategies of water avoidance, exclusion or acceptance. Dry proof construction aims to exclude flood waters from the structure using flood resistant materials and strong foundational support. Wet proof construction accepts flood waters into structures limiting structural damage due to hydrostatic pressure. Conversely, water avoidance seeks to prevent the flood water from reaching the structure (Proverbs and Lamond 2017).

A. Water Avoidance:

If feasible, water avoidance is most effective defense against flood waters. Avoidance is achieved through landscape design surrounding the building and elevation of the building itself. Elevating buildings through raising pillars, extending foundation walls and raising earth structures. Other common methods include raising buildings on stilts and placing non-essential space below the structure. Innovation in flotation technology is becoming is becoming a significant research topic in flood resilient design (Proverbs and Lamond 2017).

B. Water Exclusion (Dry Proofing):

Water exclusion focuses on strategies keeping water out of the structure utilizing water resistant construction materials and flood resistant entry point mechanisms. like doors, windows and underground pipes. Materials including, door and window guards, non – return valves and water pumps (Proverbs and Lamond 2017).

C. Water Acceptance (wet proofing):

This building design method is intended to limit damage once water has entered the space. Methods of wet proofing are often looked at as the last resort in adapting buildings to flood risk. Typically, wet proofing methods include elevating essential appliances in the building at higher elevations including locating electrical outlets and heat and air systems Wet proofing also calls for flood resistant building materials at entry points and floor (Proverbs and Lamond 2017).

Flood resilient buildings embody practices of redundancy and modularization. Redundancy refers to multiple objects within buildings that preform the same or similar task spreading the risk of failure. Modularization refers the standardization of construction enabling flexibility. Additionally, modularization promotes a decentralization of functions creating sub systems. Modularization and redundancy work together supplying buildings with backup systems and the flexibility to recover for when systems fail during times of high stress.
(Novotny, Ahern and Brown 2010)

Practicing multifunctionality is construction designs with intersections amongst the several functions creating one subsystem can perform many functions. This may seem counter to modularization however, for buildings to be resilient, cost effective and efficient cross functionality is necessary. Modularization and practicing multifunctionality can work together and is not an either-or summation. (Novotny, Ahern and Brown 2010)

Green buildings certified by the United States Green Building Council (USGBC 19) possess several flood resilient design measures discussed in the previous paragraphs. The USGBC provides more specificity on flood resilience requirements, however. To earn the points for enhanced resilience for LEED BD+C buildings cannot be built in the 500-year flood plain. If are built in the 500-year flood plain, the 1st floor of residential structures must be raised 3 feet above the FEMA defined base flood elevation. If it is a commercial structure dry proofing is recommended on the floor beneath the ground floor to seal and prevent flooding. To protect against storm surge essential permanent infrastructure should be protected through proper location and designed protection. (USGBC 19)

Best Practices: Urban Design

This section will take a closer look at common flood resilient design methods for streets, ROW's and public spaces utilizing several case studies. 30 % of land cover in New York City is devoted to streets alone (guide to greening cities). Most land in cities are either public spaces, streets or ROW's. These spaces are where humans interact socially or relax in nature away from the inside of a building. Flood resilient urban design can satisfy these human functions and help process excess flood waters.

Flood Resilient Corridor and Street Design

Street design has trended toward the new urbanist approach in recent years emphasizing walkability and the relationship to the surrounding buildings. This trend is showing up in cities as complete streets which encourages multimodal transportation, smaller car lanes, dedicated bike lanes, on street parking and larger pedestrian zones. Green streets are an urban design method that combines complete street concepts with green infrastructure strategies.

The City of Chicago has transformed much of its streetscape to embody green street concepts. The Green Streets Program of the city of Chicago is dedicated to enhancing streets with green infrastructure through implementing 70,000 tree plantings in 20 years. The focus is on neglected neighborhoods and streets with an abundance of gray infrastructure often causing a hotter and more flood prone environment. The increased amount of green infrastructure through the green streets program allows for better natural drainage during heavy rainfall

events, while providing additional canopy coverage to cool the existing streets. (Sustainable Urban Infrastructure Guidelines, 14)

The City of Chicago is also incredibly keen on implementing permeable pavers in the ROW. Through Chicago's Green Alley's program, the City has transformed much of its 1,900 miles of public alleys into storm water havens. Using permeable pavers 80% of all rainwater contacting the surface of these alleys will infiltrate through the soil providing enough groundwater recharge and much needed urban flooding relief. Green alleys provide flood relief to properties adjacent to the alley ways by using permeable paving instead of asphalt. The pavers help cultivate an inviting public environment and are made from recycled materials benefiting an overall sustainable agenda. (Attarian, 2010)

Flood Resilient Neighborhood and Park Design

The Augustenborg neighborhood in Malmo, Sweden is renowned as an eco-city becoming one of Sweden's largest urban sustainability initiatives. One of the largest success of this project has been the towns open storm water drainage system. A drainage system that decentralizes the source of entry for storm water, by utilizing a diversity of green infrastructure methods at differing scales. Transitioning from conventional systems combining sewer and stormwater, Augustenborg promoted features of modularization producing effects that increase water quality and decreases urban flooding. The open drainage system incorporates green roofs, bio swales, small wetlands and wet detention ponds. Figure 2.7 shows one aspect of the new stormwater system that utilizes a variety of green infrastructure techniques. By accounting for all the drainage through natural green infrastructure, the neighborhood now separates the sewerage from storm water providing a more flood resilient built environment (Novotny, Ahern and Brown 2010). This example incorporates best practices in green infrastructure and system modularization while also adhering to planned unit development standards of land use best practices.

Figure 6

Flood resilient Neighborhood design embody practices described in the Augustenborg example; however, all neighborhoods vary Figure 6 shows an example of water retention practices in Augustenborg. Flood resilient practices best suited for Augustenborg might not be best suited for high density urban neighborhoods.

Understanding differences among places, LEED ND sets a list of formal standards neighborhoods of all types could strive for LEED ND is a certification from the United States Building Council, acknowledging a projects application of resilient design practices. These standards are organized into categories maintaining specific requirements and prerequisites to complete the LEED ND certification. These categories are listed below.

- Smart Location and Linkages
- Neighborhood Pattern and Design
- Green Infrastructure and Buildings

The standards developed by the USGBC recognize several aspects of flood resilient design including;

- Floodplain avoidance,
- Site Design for Habitat or Wetland and Water Body Conservation
- Tree-Lined and Shaded Streetscapes
- Compact Development
- Connected and Open Community
- Rainwater Management
- Minimized Site Disturbance

(USGBC, 17)

Best practices in flood resilient park design reinforce principles discussed of resilient neighborhood design. Understanding the role of landscape ecology within an urban context and applying concepts of multifunctionality; redundancy and modularization creating ecological networks that sustain biodiversity and promote connectivity. Common best practices of resilient Parks design include;

- Stormwater Infiltration
- Precipitation Interception
- Mitigation of Urban Heat Island Effect
- Carbon Sequestration
- Nutrient Cycling
- Air Quality Mitigation

Figure 7

Figure 7 shows a tidal parklet in Queens, New York. This is a prime example of how a flood mitigating structure can be turned into a public amenity.

Flood Resilient Coastal Management

Coastal environments are entirely dynamic where two natural environments meet, and the built environment is caught in the crosshairs. The impacts from climate change are often the most visible on the coast. Sea level rise contributes to tidal inundation, erosion and salt water intrusion; extreme weather events contribute to destructive storm surge, waves and erosion. These factors impact the built environment through more frequent and severe flooding. Coastal management has turned to adaptation planning and ensuring grey and green infrastructure methods are in place to maintain a resilient coastal design.

Natural coastal infrastructure protection includes salt marshes, mangroves, beach, dunes, oyster and coral reefs. Natural coastal defenses are adaptable to sea level rise and can self-recover after storms. While these methods are not applicable in all coastal environments, they provide a cost-effective defense against storm surge, erosion and waves. Built protections

include seawalls, levees and bulkheads which often degrade the coastal environment while providing protection. Built methods are more expensive and intrusive leaving the environment less resilient after its useful life. (PAS 581)

Class	Best Practices	Documents Sourced
Resilient Zoning	• Residential Subdivision Ordinances • Planned Unit Developments • Performance Based Zoning-Form Based Code • Overlay Zoning	
Flood Resilient Site Design	• Reducing pollutant loads in rainwater • Reduce downstream damage from runoff • Safely move, control and contain rainwater • Capture rainwater for reuse (of all kinds human and natural from irrigation to toilet flushing to groundwater recharge) • Restore or create habitat.	
Flood Resilient Building Design	• Water Avoidance • Water Exclusion (Dry Proofing) • Water Acceptance (wet proofing): • Practices of redundancy and modularization • Practice multi functionality	
Flood Resilient Neighborhood Design	• Open storm water drainage system • Green infrastructure methods • Floodplain avoidance • Compact development • Rainwater Management	
Flood Resilient Park and Coastal Design	• Natural Coastal Infrastructure • Sand Dunes, salt marshes, mangroves, oyster and coral reefs • Built Coastal Infrastructure • Seawalls, levees and bulkheads • Hybrid Built and Natural Coastal Infrastructures • Smart Location and Linkages • Storm-water infiltration	
Flood Resilient Corridor and Street Design	• Green streets • Permeable pavers • Bio-swales • Tree lined and shaded streetscapes • Smaller car lanes and dedicated bike lanes	

Figure 8

Literature Review Conclusion

The preceding review explores a range of flood resilient best practices and provides case examples showing how these practices are implemented. Figure 9 displays the extracted best practices from the document review as well as the organizing classes. This best practice document review was organized by Zoning-Land Use, Urban Design and Building Design to broach the comprehensive aspect of flood resilient planning and design. Expanding on existing literature, this research will aid local governments in demonstrating how their resilience strategy can be improved upon. While all cities have a different set of needs, understanding best practices in flood resilience will help local governments choose which methods work best for their jurisdiction. The following review will explore the documents containing flood resilient initiatives and regulations of NYC and the borough of Queens. This will establish two separate document review enabling the comparative analysis between the best practice document review and the policy document review. The findings will show where Queens is excelling in flood resilience and how they may be able to improve.

Methods

The documents selected in the following policy document review reflect a comprehensive outlook of local policy and regulation in flood resilience of NYC and Queens. The policy document review is segmented to reflect the level of governance and location the policies and recommendations originate and adhere. An analysis will be conducted comparing the findings from the Best Practice document review and the Policy document review

The organization of the Policy document review follows the hierarchical structure of NYC's flood regulation policy. Figure 9 illustrates this structure while organizing the documents reviewed for analysis. Additionally, the review will segment regulations and initiatives found in these documents into categories of resilient zoning, coastal protection, incentive-based policy, building elevation standards, floodproof construction standards, resilient park and open space

Figure 9

standards and resilient street and corridor design. Further assessing how the policies within these classes meet best practice standards will support goals to improve local flood resilience regulation. In figure 10 the web graphic represents the segments of flood resilient policies in the

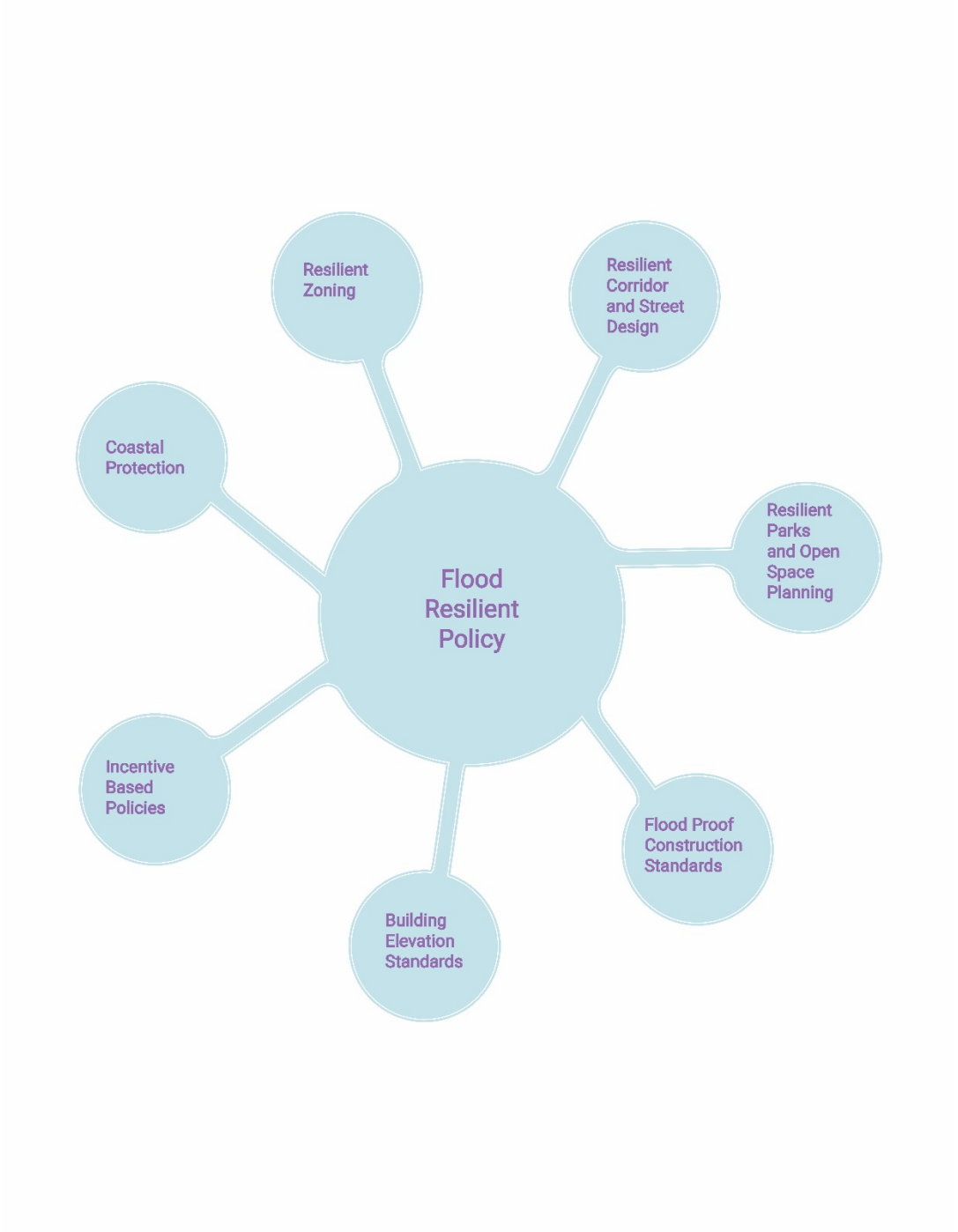

Figure 10

analysis. The assessment will show how applications are underutilized in specific areas of flood resilience while recognizing applications that go beyond the commonplace policy. The basis of local flood resilience policy originates from flood maps and corresponding regulations created by the Federal Emergency Management Agency (FEMA). The FEMA documents reviewed entail construction and design requirements for designated zones in the floodplain. At the local level,

several of the documents are sourced from the municipal jurisdiction of New York City, where the Queens borough is located. Further documents were collected and reviewed pertaining to policies and initiatives unique to neighborhoods in Queens. This diverse document review will enable a comprehensive analysis on how the most vulnerable neighborhoods in NYC and Queens are planning for flood resilience.

Policy Assessment

The policies, standards and design guidelines found in the reviewed documents will be assessed based on four standards of criteria. These criterions include determining if the policy adheres to established best practices in flood resilient design. In determining how or whether a policy follows established best practices will enable targeted responses in policy domains which do not employ best practices. Policies will be analyzed for if they extend past the required flood resilient design standards enforced through FEMA. This criterion is critical to policy improvements, as FEMA generally employs policies based on historical data which does not account for projected impacts of climate change. Policies that do not meet this criterion are performing at the minimum standard required by FEMA and are at increased risk based on FEMA's underwhelming policy developments. Policies meeting the collaborative and community-based criterion are pursuing collective action through communities. Through localizing a planning effort, people want to be engaged and help build a more resilient community. These policies foster collaboration by engaging the many stakeholders of a community as well as experts outside of the community. Policies meeting the creativity criterion show a new approach to resilient design policy determined as utilizing a best practice in a unique way or creating a new practice improving flood resilience. Figure 11 visualizes the criterion values and categories in a pyramid scale.

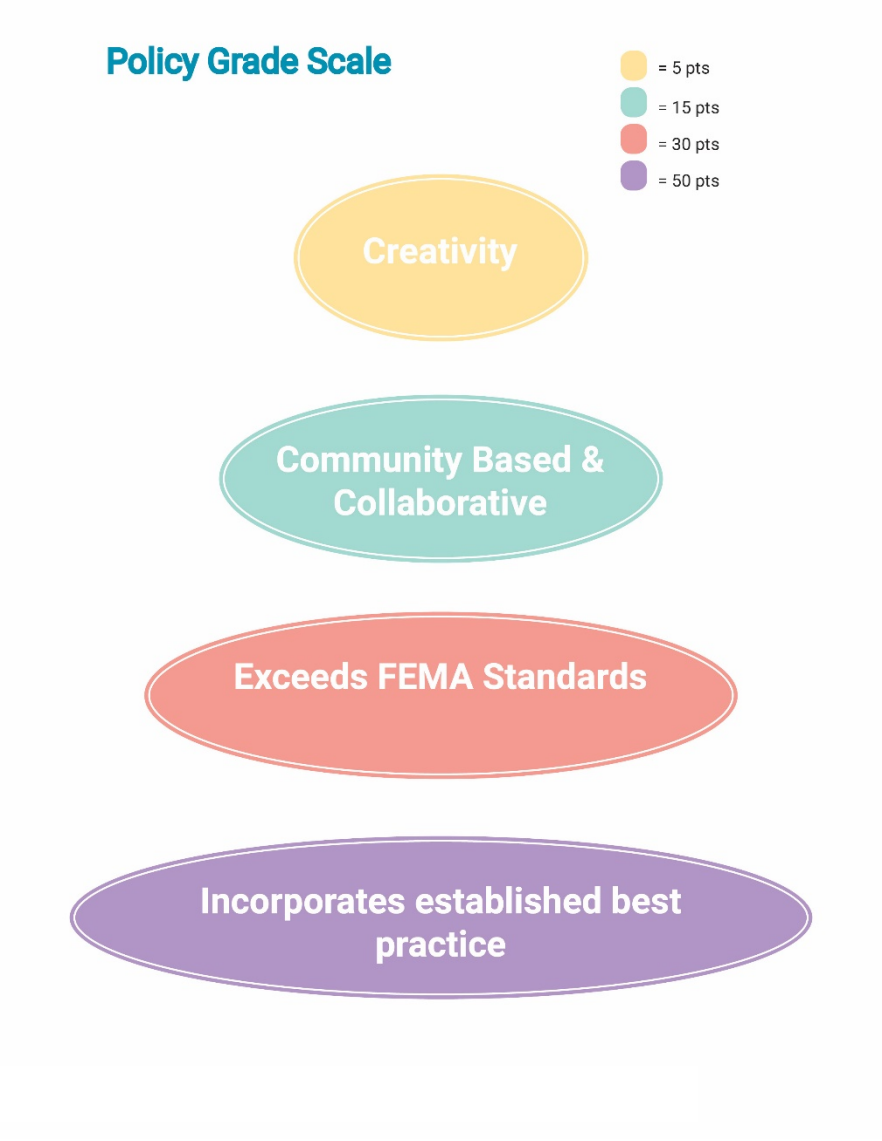

Figure 11

Policy Document Review Narrative

The policy document narrative summarizes documents forming the policy framework of resilient design policy in New York City. Technical documents were utilized to understand the federal requirements within the 100-year floodplain. Furthermore, documents related to flood resilient planning and design in the City of New York were reviewed and neighborhood plans in Queens were summarized. Showing these scales of flood resilient policy formation and implementation is helpful in targeting areas to improve policy.

FEMA:

Flood Resilient Design and Construction:

Issued by the American Society of Engineers in 2015, this document is a comprehensive guide to flood resilient design and construction. FEMA adopts the practices outlined in this guide to regulate building design and construction in the designated floodplain. The review will focus on details pertaining to coastal high hazard areas, dry and wet flood proofing, materials requirements for Flood Hazard Areas and foundation requirements.

Flood Damage – Resistant Materials Requirements for Buildings Located in Special Hazard Areas in accordance with the National Flood Insurance program:
Released in 2008 through FEMA's Risk Management program, this technical bulletin outlines regulations codified by the National Flood Insurance Program for flood damage resistant materials. This is a technical document that local governments must incorporate into their codes and understand throughout permitting to ensure adherence. The review focuses on construction examples in the flood plain and the required use of flood damage-resistant materials

NYC Policy and Regulation:

A Stronger more Resilient New York:
This is a comprehensive plan released by the City of New York in 2013, approximately one year after hurricane Sandy impacted the region. The document outlines the need for resilience strategies along the coastline and details a wide variety of initiatives to improve floodproofing and recovery against severe flooding. The review will focus on implications for coastal development and building design in the city as well as specific neighborhood resilience plans in Queens, NY. The document overviews several design alternatives using the inundation from hurricane Sandy as a measuring stick for policy effectiveness.

Climate Resiliency Design Guidelines:
Issued in 2018, this document supplements existing historical climate change data with regional climate change projection data. The New York Panel on Climate Change is the entity providing the projection data which this document uses to formulate design guidelines for the city's infrastructure and capital projects. The review will focus on design guidelines related to sea level rise and storm flood waters.

Flood Resilience Text Amendment:

This document is a useful guide to the 2018 Flood Resilience Text Amendment. The document addresses how to zone for new building standards implemented by FEMA. Several zoning issues come up as a result of the new FEMA standards and are addressed in this document. The review will analyze the solutions to issues of streetscape, access and building height among other issues related to flood resilient design and the urban environment.

Resilient Zoning: Neighborhood Outreach Summary

The 2013 resilient zoning text amendment reflected building standards administered by the FEMA post Hurricane Sandy. The text amendment was a temporary solution to enable a speedy recovery and rebuilding processes meeting the standards released by FEMA. This document summarizes the community outreach effort to reach a more permanent resilient zoning measure. The document surveys over 100 community meetings seeking potential solutions which enable resilient design retrofits and new construction more attainable.

High Performance Landscape Guidelines: 21st Century Parks for NYC

This document was published in 2010 created through a partnership between the City of New York Parks and Recreation and The Design Trust for Public Space. The document sets forth best practices for park design while focusing on ecological impact and human interaction. The review will focus on the initiatives where park and public space design supports stormwater systems.

Coastal Protection: Designing for Flood Risk

This document was published in June 2013 by the Department of City Planning and funded through the New York-Connecticut sustainable communities consortium under the Department of Housing and Urban Development. The documents intended goals are to recommend urban design methods which balance urban livability within our public spaces and flood resilience. Flood resilient design can often lead to undesirable public space. The document introduces the basic principles of flood resilient construction and quality urban design contributing to active streets, well used public spaces and inviting facades. The document recommends several design strategies to deal with these divergent design philosophies including subtle changes in ground floor use enabling flood protection and a vibrant public realm.

Urban Green Building Council: Building Resiliency Task Force

The Building Resiliency Task Force was contracted by the City of New York to perform a policy audit on the initiative of Mayor Michael Bloomberg. The document parses through various existing flood resilience policies and gives specific recommendations for how to improve and better implement. The document proposes new policies which extend how existing policies are implemented currently. The Building Resiliency Task Force is a group of professional architects, planners, urban designers and engineers working for the Urban Green Building Council.

QUEENS:

Resilient Neighborhoods: Old Howard Beach, Hamilton Beach and Broad Channel

This document was issued in 2016 as a part of NYC's Resilient Neighborhood initiatives originating in the City's comprehensive plan. The document focuses on tailoring resilience strategies for specific neighborhoods in Queens focusing on reducing flood risk and allowing for adaptive capacity. The neighborhoods covered in this document are becoming increasingly susceptible to frequent tidal flooding and storm surge inundation caused by hurricanes. The document outlines zoning, resilient building and critical infrastructure improvement strategies recommended for this area.

Cloudburst Resiliency Planning Study

Published in 2017 by NYC Department of Environmental protection, this document details a study on cloudburst events or heavy rainfall in southeast Queens. The study examines how the physical environment interacts with sudden and heavy precipitation and recommends planning and design strategies to mitigate flooding. The document further details the expansive place-based benefits from implementing the recommended strategies ranging from financial to community.

Resilient Retail: Coastal Climate Resiliency

Released in 2016, this document focuses on protecting NYC's retail corridors from impacts of severe flooding. The study focuses on how to retrofit existing business to adhere to the changing FEMA flood risk requirements as well as how to maintain a walkable, accessible urban space. Several retail corridors in this study are in Queens along the floodplain. The review will focus on the planning and design strategies for mitigating flood risk to commercial corridors.

Analysis

The following analysis reflects how well flood resilience policy in New York City meets the assessment criteria described in the methods section. The analysis briefly documents the policies intentions and answers questions related to meeting the assessment criteria. There are 21 total policies reviewed and assessed, three from each flood resilient policy class.

The answers to the evaluative questions will enable a score for each policy, these questions are: Is this policy reflective of recognized best practices? Is this policy going above the federal regulation mandated by FEMA? Is the policy working collaboratively with the community and other agencies? Is the policy a new approach in flood resilient design? The 21 policies consist of various forms of initiatives, recommendations and adopted policy. For the purposes of this analysis all 21 policies will be reviewed with equal weight not considering whether the policy has been adopted.

Resilient Zoning

Policy: Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year flood plain.

Found in the New York City document “A Stronger More Resilient New York”, this initiative describes a collaborative effort to improve the flood resilience of buildings. Through neighborhood specific land use studies, the initiative focuses on areas where flood exposure is greatest and neighborhoods where small lot site conditions hinder abilities to retrofit homes for flood resilience. The current zoning discourages the retrofits necessary to meet FEMA regulations and flood resilient construction standards through minimizing allowable ground floor space and creating barriers and unpleasant design conditions at access points. The zoning issues include height, access, placement of mechanical systems, parking and use of ground floor space. The initiative promotes zoning changes allowing flexibility in measuring heights of elevated buildings to allow for more floor space, allows parking under structures and

allows mechanical equipment to be elevated from the ground level. Furthermore, the initiative allows greater flexibility in the design of ramps, stairs and lifts promoting greater access (City of New York, 13).

Is this policy reflective of recognized best practices?

- Yes, the initiative uses flood hazard overlay zoning to enable flexible zoning standards in neighborhoods within the 100-year floodplain.

Is this policy going above the federal regulation mandated by FEMA?

- No, the initiative is proposing zoning solutions to enable homeowners to retrofit their homes in order to meet FEMA standards.

Is the policy working collaboratively with the community and other agencies?

- Yes, the land use studies which promote these recommendations are neighborhood based with significant community input. The Department of City Planning engaged with the local design community to further collaborate on their approach.

Is the policy a new approach in flood resilient design?

- No, the initiative encourages flood resilient design, however, does not exceed commonplace standards for flood prone urban zones.

Policy: Planting requirement for Single- and Two-Family Residences

The policy is found in the “Flood Resilience Zoning Text Amendment” under Design requirements. The policy requires plantings at least three feet high and three feet in depth where provided as a mitigation element. The total length of the planted areas shall be greater than 60 percent of the lot width (Flood Resilience Text Amendment, 13).

Is this policy reflective of recognized best practices?

- Yes, the policy reflects best practices in flood resilient site design restoring vegetation.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, The FEMA Flood resilient design guides do not have special requirements for plantings and vegetation.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is found in the flood resilience zoning text applying to all single and two family zoned lots in the City. No other agency was involved in preparing this policy.

Is the policy a new approach in flood resilient design?

- Yes, the policy requires plantings to be at minimum 60 percent the width of the lot. This requirement has a flood resilience mitigation approach contrary to the aesthetic approach.

Policy: Buildings in the 100-year floodplain cannot have subgrade spaces, such as basements or cellars. Ground-floor use is limited to parking storage or access in residential buildings, since this space must be wet-floodproofed.

This policy is found in the "Flood Resilient Text Amendment" and requires the lowest occupiable space to be located at or above the design flood elevation determined by the ASCE Flood Resistant Design and Construction Standards. The design flood elevation is either at or above the FEMA determined base flood elevation. A significant portion of residents have homes with ground floor level occupiable space and the new requirement caused adjacent zoning issues for building height, access, parking, mechanical systems, ground floors and streetscapes. These issues were rectified temporarily providing flexibility to allow for retrofits that meet the design flood elevation (Flood Resilience Text Amendment, 13).

Is this policy reflective of recognized best practices?

- Yes, the policy reflects best practices in overlay zoning where special requirements supplemental to the underlying code promote flood resilient design.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, The FEMA elevation requirements under the National Flood Insurance Program mandate structures to be built at the base flood elevation. This policy requires structures to be built at the design flood

elevation, a standard provided by the ASCE Flood resistant design and construction manual. The design flood elevation is 1-3 feet above the base flood elevation depending on the structures use and occupancy status.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is found in the flood resilience zoning text applying to all single and two family zoned lots in the City. No other agency was involved in preparing this policy.

Is the policy a new approach in flood resilient design?

- No, the policy was adopted to meet the new construction standards set by FEMA in 2013. The only difference between the FEMA regulation and the City of New York is building at the base or design flood elevation levels.

Coastal Protection

Policy: Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques.

This initiative is found in the Coastal Protection chapter of “A Stronger More Resilient New York” document. The premise of this initiative underlies fast paced trends in coastal resilience research and innovation. The initiative promotes a collaborative effort to determine if innovative coastal protection techniques are cost effective and realistically implementable. The initiative provides a working collaborative framework with academic and scientific institutions including the Jamaica Bay Science and Resilience Center. Techniques such as “Sand Engines” (a new technology supplementing beach nourishment and sand dune maintenance) requires further research to determine its feasibility (City of New York, 13).

Is this policy reflective of recognized best practices?

- Yes, the policy reinforces the importance of natural coastal infrastructure through the ecology of sand dunes, salt marshes, sea grass and mangroves.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, The FEMA Flood resilient design guides do not have initiatives pursuing research and collaboration seeking methods for coastal protection.

Is the policy working collaboratively with the community and other agencies?

- Yes, the foundation of the policy is collaboration with the community to seek more effective means of reducing flood risk to coastal neighborhoods. The initiative seeks collaboration as its main task and promotes community engagement by focusing its collaborative efforts on local academic and scientific institutions

Is the policy a new approach in flood resilient design?

- Yes, the initiative is designed to uncover new approaches in flood resilient design. The field of flood resilient design is gaining more attention in the last decade which has demanded increased research efforts. New technologies and approaches are in the lab and this initiative plans test and determine their feasibility.

Policy: In waterfront areas accessible to the public, require wind and salt-tolerant trees and maintain regular tree pruning. Encourage private owners to follow the same practice.

This is an initiative recommended by the Building Resilience Task Force of the US Green Building Council prepared for the City of New York. The recommendation seeks to build further resilience by avoiding damage from damaged trees during severe storms impacting buildings, utility lines, people and property. Requiring wind and salt tolerant trees would reduce the risk of damage during severe weather events. Furthermore, requiring specific tree and vegetation types can improve flood resilience if there is a change from impervious surface to salt tolerant tree or vegetation (BRTF, 13).

Is this policy reflective of recognized best practices?

- Yes, the policy reflects best practices in natural coastal infrastructure and stormwater infiltration techniques.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, The FEMA Flood resilient design guides do not have special requirements for plantings and vegetation.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is the result of a collaborative effort with the United States Green Building Council to shape flood resilient design policy in New York City.

Is the policy a new approach in flood resilient design?

- Yes, the policy requires plantings to be wind and salt resilient, this is creative because trees that are salt and wind resilient are often non-native to locations in New York City. Introducing non-native plant species is a creative technique because most flood resilient best practices and zoning policy incentivize native plantings.

Policy: Plan for the adaptive stewardship of vacant city-owned properties to be used for coastal protection.

This initiative is found in the resilient neighborhood's series in the plan for Old Howard Beach, Broad Channel and Hamilton Beach. The initiative is part of the conclusions made by the document to reduce risk to development in coastal communities. The initiative suggests utilizing vacant city owned lands for coastal protection methods and to seek the most appropriate cost effective and impactful method for these vacant city owned parcels. The initiative does not suggest what these coastal protection measures would be, only that coastal protection methods should be explored and utilized on these parcels (Resilient Neighborhoods: Old Howard Beach, Hamilton Beach and Broad Channel, 16).

Is this policy reflective of recognized best practices?

- Yes, while the initiative does not fully prescribe flood resilient design best practices the initiatives proposes for these city-owned vacant parcels to be used for coastal protection. If properly implemented the policy is reflective of smart linkage and location practices in coastal protection. Strategic placement of coastal protection methods will reduce risk to communities.

Is this policy going above the federal regulation mandated by FEMA?

- No, the initiative does not fully describe what they will do with the properties, depending on how the properties are used the initiative currently does not go above federal regulations mandated by FEMA.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is the result of a collaborative effort with the neighborhoods of old Howard beach, Broad Channel and Hamilton Beach. The document this policy is sourced from is the result of collaboration with community leaders and residents in reducing flood risks in their community.

Is the policy a new approach in flood resilient design?

- Yes, the policy requires plantings to be wind and salt resilient, this is creative because trees that are salt and wind resilient are often non-native to locations in New York City. Introducing non-native plant species is a creative technique because most flood resilient best practices and zoning policy incentivize native plantings.

Incentive Based Policy

Policy: Dry-Floodproofed ground-floor space can be exempted from the amount of floor area allowed and an equivalent amount of space can be constructed elsewhere on the site.

This policy is found in the Resilient Zoning Community Outreach document and promulgates a solution for high upfront costs of dry-floodproofing commercial buildings and storefronts. The conclusion amongst community stakeholders was that incentives for dry floodproofing storefronts were necessary and zoning allowances such as expanding allowable ground floor space would encourage more store owners to dry-floodproof their businesses (NYC Planning, 18).

Is this policy reflective of recognized best practices?

- Yes, this policy encourages a water exclusion flood resilient building design best practice. Commercial storefronts with dry-floodproofed

ground floors maintain the active urban environment promoting their business while reducing the risk of flood damage.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, the initiative does rise above requirements from FEMA that requires new non-residential construction within the 100-year flood plan to be dry-floodproofed. The initiative is an incentive for existing non-residential storefronts and encourages the expansion of the FEMA requirements.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is the result of community engagement with neighborhoods throughout New York City. Particularly, local business owners of tight knit coastal communities vouching for methods that allow future benefits of investments in resilient design.

Is the policy a new approach in flood resilient design?

- No, the policy encourages dry-proofing of existing non-residential buildings by allowing additional ground floor space. This type of incentive is not new trading one allowance for the promotion of a certain practice has been utilized in city policy and zoning quite often.

Policy: Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandates.

This initiative is found in the buildings chapter of “A Stronger more Resilient New York” document. The initiative provides the framework for an incentive program with goals of ensuring the vast majority of built square footage in the 100-year floodplain is significantly better protected from flood risk than prior to Hurricane Sandy. The incentive program intends to promote core flood resilience measures which include various building fortification methods and flood resilient best practices. The City will grant 1.2 billion dollars to this program in the form of grant and loans to help building owners with upfront costs of retrofitting and building flood resilient construction (City of New York, 13).

Is this policy reflective of recognized best practices?

- Yes, the policy would allow for a higher percentage of buildings within the floodplain to become more flood resistant utilizing best practices in building elevation and floodproofing.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, the initiative does rise above requirements from FEMA because the standards defined in the core flood resilience measures are not all defined in the FEMA guidelines nor does FEMA require incentive programs enabling building owners the ability to retrofit.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is the result of community engagement with neighborhoods throughout New York City. Particularly, local business owners of tight knit coastal communities vouching allowances to improve the resilience of their businesses against floods as well as the as for the community benefit.

Is the policy a new approach in flood resilient design?

- No, the policy encourages flood resilient design but is not a new approach. Incentives based policy through zoning, grants or loans is commonplace in urban planning.

Policy: The development of incentive-based programs and the use of bidding scoring systems that recognize improved contractor education and training need to be carefully vetted prior to implementation to ensure legal compliance.

This policy is part of an overall best practice initiative to improve contractor qualification evaluation and parks staff training. The policy is found in the Design guidelines for Parks and Landscapes published in collaboration with City of New York Parks and Recreation Department and the Design for the Public Trust. The policy incentivizes contractors to learn new skills as best practices in park and landscape design change. The benefit from to the contractors is a signatory or designation of skill level and reliance in the various types of projects and

construction experience. The contractor benefits through an improved reputation and increased work with higher bid status (Design Trust for Public Space and the City of New York, 10).
Is this policy reflective of recognized best practices?

- No, an incentive program for contractors was not found in the best practice review.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, contractor incentive programs are not mandated by FEMA. Certificates adhering to construction standards are required, however incentives for contractors are not within these mandates.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is working with the community through its employees and the contractors. Credential testing offered by third party institutions are incentivized by this program and benefit the quality of construction as well as the reputation and economic well-being of contractors and park employees.

Is the policy a new approach in flood resilient design?

- No, the policy encourages contractors to achieve credentials in flood resilient techniques for park and landscape design. Credentials are commonplace in most industries and the incentive to achieve them is always reputation and higher income. What is unique however, is the specificity of credentials incentivized to flood resilient park and landscape design.

Building Elevation Standards

Policy: Flood Resistant Construction Elevation (FRCE) required by the City of New York, mandates an additional one to three feet above the latest FEMA Base Flood Elevation requirement.

The originating source for defining the Flood Resistant Construction Elevation is the ASCE 24 document referenced in the City of New York's Building Code. This document specifies the recommended elevation for occupiable space dependent on the structure's occupancy and use.

Any space below this that is occupied must be dry flood proofed and if unoccupied must be wet flood proofed (ASCE, 15).

Is this policy reflective of recognized best practices?

- Yes, mandating an elevation requirement for buildings in the floodplain is utilizing best practices in water avoidance and wet proofing storage space below the FRCE is utilizing best practices in water acceptance.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, the base flood elevation marked by the FEMA flood maps is the stated requirement by FEMA. The FRCE required by the City of New York uses the ASCE 24 document to mandate elevation requirement for different occupancy levels, location and building uses. Depending on these factors the elevation of the lowest occupiable floor without dry flood proofing ranges from one to three feet above the stated base flood elevation by FEMA.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is working through several agencies within the city and collaborating with ASCE for the design guide requirements. These standards were agreed upon utilizing information released by FEMA 2015 flood maps, recommendations by ASCE and interagency meetings between the planning department and building department at the City of New York.

Is the policy a new approach in flood resilient design?

- No, policies requiring additional elevation for occupiable space is commonplace in highly populated coastal regions. FEMA suggests requiring additional space to account for modeling errors and external forces unaccounted for in the base flood elevation.

Policy: Adjust ground-floor use requirements to maintain street-activating uses where possible in cases where ground floors are substantially above adjacent grade.

This policy recommendation was found in the Designing for Flood Risk published by the New York City Planning Department. The policy recommendation charges at issues relating to impacts to the public realm and active streetscapes. Access and aesthetics are greatly impacted by building elevation requirements and dry flood proofing the ground floor is uneconomical. This policy proposes a solution to require active uses on the lowest floor above the FRCE or Design flood elevation and for space below to require plantings and screenings which mitigate negative impacts of elevated ground floors on the public realm (Burden and Bell, 13)

Is this policy reflective of recognized best practices?

- Yes, the policy is reflective of best practices of neighborhood urban design. The policy promotes urban characteristics of a connected and open community and neighborhood pattern and design. Best practices as described in the LEED ND project qualification standards.

Is this policy going above the federal regulation mandated by FEMA?

- No, this policy is intended to mend challenges caused through the elevation standards of the city of New York in the floodplain. As these building elevation standards create a negative impact on the public realm and hurt the ability to access buildings requiring excessive ramps to meet ADA requirements. This policy does not improve flood resilience further than the standards of FEMA.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy's intent is to promote the community character and maintain the public realm. If applied, this policy would need to engage the community to identify active uses and spaces best applied.

Is the policy a new approach in flood resilient design?

- Yes, this policy recommendation is a savvy idea that allows for flood resilient building design while promoting an active public environment. The policy is creative in its ability to balance flood resilience and maintaining community character and activity.

Policy: Establish a sea level rise-adjusted Design Flood Elevation

The policy establishes the increased height of the base flood elevation due to sea level rise, plus freeboard depending on the critically of the facility. The sea level rise adjustment depends on the useful life of the facility. This is an important policy to fill the modelling errors of the base flood elevation maps. FEMA's 100-year flood elevation base map only uses historical data to model its overlay to map flood zones. The FEMA model is handicapped in other ways; however, this policy would improve the accuracy of mapping flood zones. The New York City Panel on Climate Change informs policies in the region based on historical and projected data on climate. This panel directly informed the creators of this policy to better inform residents and build a more resilient City. (Climate Resilience Design Guidelines, 18).

Is this policy reflective of recognized best practices?

- Yes, the improved accuracy and scope of sea level rise adjusted floodplain models enable more comprehensive decisions to practice flood resilient neighborhood design including floodplain avoidance and compact development.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, the sea level rise adjusted model for the 100-year floodplain is not currently modeled by FEMA. FEMA only utilizes historical data for its floodplain modeling.

Is the policy working collaboratively with the community and other agencies?

- Yes, the policy is the result of the work of local and regional agencies to supplement flood plain models. The New York City Panel on Climate Change collaborates with the science community and informs policy makers in New York based on scientific data.

Is the policy a new approach in flood resilient design?

- Yes, the policy exhibits a new approach to mapping flood hazard areas that includes supplemental data inputs to traditional historical data which provides better information in implementing flood resilient design best practices.

Flood Proof Construction Standards

Policy: Dry and wet floodproofing best practices utilized for residential and nonresidential uses.

This policy is found in the "Building Resiliency Task Force" document from the US Green Building Council and the flood resilience zoning text amendment in New York City. These policies describe how wet and dry flood proofing methods should be utilized and how they are implemented currently. Wet flood proofing shall only apply to residential uses whereas dry flood proofing shall apply to non-residential uses. However, the BRTF recommends dry flood proofing basements of residential uses. Dry proofing nonresidential uses requires all materials below the design flood elevation to be flood resistant. Manufacturing requirements for flood resistant materials include saltwater resistant mixtures of concrete, production of galvanized steel and preservative treated wood (ASCE, 15). Wet flood proof tactics include techniques that minimize damage to the structure associated with flood loads (ASCE, 15) (BRTF, 13).

Is this policy reflective of recognized best practices?

- Yes, dry and wet floodproofing are flood resilient design and construction best practices and are required for several structural uses within the floodplain.

Is this policy going above the federal regulation mandated by FEMA?

- No, this policy is an exact reflection of what is required in the FEMA standards under the flood resistant design and construction standards of ASCE.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is an interagency collaborative where the City of New York utilizes the standards required by the ASCE flood resistant design and construction guide to mandate floodproofing requirements. The policy does not indicate community focused efforts to meet the requirement for this category.

Is the policy a new approach in flood resilient design?

- No, the policy exhibits design and construction methods common in floodplains.

Policy: Capture stormwater to prevent flooding

This policy addresses localized stormwater flooding caused by existing building and streets not meeting the new rigorous stormwater standards administered for new developments. The policy is a recommendation by the NYC Building Resiliency Task Force of USGBC. The policy recommends standards which facilitate stormwater capture and infiltration. One standard includes limiting impervious surface area in residential backyards. Additionally, installing subsurface detention systems through the public realm and improving sidewalks standards requiring permeable surfaces to improve stormwater management (BRTF, 13).
Is this policy reflective of recognized best practices?

- Yes, these standards are reflective of flood resilient corridor and street design as well as flood resilient site design.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, the standards in this policy are not required in the floodplain by FEMA and the recommended standards promote flood resilience.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is the result of a collaboration with the USGBC an outside national organization specializing in resilient and sustainable design but does not indicate neighborhood specific strategies or community-based methods.

Is the policy a new approach in flood resilient design?

- Yes, the standards required by the policy are not new to the field of flood resilient design, however they are unique to the location and were created utilizing a unique collaboration with the USGBC.

Policy: Design buildings to resist forces from higher design flood elevations.

This policy is specific to below grade dry flood proofed structures and utilizes methods that aim to improve resistance to hydrostatic forces preserving the structures integrity. The policy is a recommendation by the Building for Resiliency Task Force with USGBC. The design and construction recommendations supporting this policy include structural reinforcement and support mechanisms which resist hydrostatic forces beyond the original design requirements (BRTF, 13).

Is this policy reflective of recognized best practices?

- Yes, these standards are reflective of flood resilient floodproofing best practices reflective of water exclusion methods.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, the purpose of this policy is to improve hydrostatic resistance beyond the original design requirements for flood proofing below grade space. The policy is enforcing existing buildings with below grade space to dry flood proof to these standards which FEMA does not.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is the result of a collaboration with the USGBC an outside national organization specializing in resilient and sustainable design, however the policy does not meet the community component because it does not specify neighborhood efforts and community engagement.

Is the policy a new approach in flood resilient design?

- No, the policy is an improvement to and already existing common practice in flood resilient design.

Flood Resilient Park and Open Space Design

Policy: Manage stormwater adjacent to restoration areas to prevent any additional stormwater runoff to these areas.

This policy is recommended in the High-Performance Landscape Guidelines for New York City. The policy acknowledges that different locations have different ecosystems and require different methods in maintaining the policy. Some of the suggested methods include the use of salt marshes, freshwater wetlands, and stream or riverbank restoration to capture the additional stormwater runoff. In addition to utilizing ecosystems several green infrastructure methods are recommended as well as stormwater capture and reuse for site needs with the intention of managing stormwater adjacent to restoration areas (Design Trust for Public Space and the City of New York, 10).

Is this policy reflective of recognized best practices?

- Yes, the standards in this policy are reflective of flood resilient site design best practices as well as flood resilient coastal and park design best practices.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, FEMA regulations do not focus on managing stormwater runoff and public space design. The FEMA regulations are more focused on building and site design and construction.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is the result of a collaboration with between the NYC parks and recreation department and the Design trust For Public Space, however the policy does not method community engagement or neighborhood specific efforts.

Is the policy a new approach in flood resilient design?

- No, the policy is supplemental to and already existing common practices in flood resilient park and open space best practices as well as resilient site design best practices.

Policy: Position absorptive landscapes deliberately maximizing flood control potential

This policy found in the High-Performance Landscape Guidelines for New York City document is a practice underneath the overall policy to create absorptive Landscapes. The practice utilizes methods of smart location and linkage of landscapes to promote absorption. It's two critical practices including positioning absorptive landscapes to maximize disconnection of impervious surfaces from the conventional storm water system and optimizing infiltration opportunities by connecting absorptive landscaped areas. The overall intention of these practices is to decrease the amount of water entering the conventional stormwater system (Design Trust for Public Space and the City of New York, 10).

Is this policy reflective of recognized best practices?

- Yes, the policy reflects best practices in resilient park and coastal design as well as flood resilient site design.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, FEMA regulations do not focus on managing stormwater runoff and public space design. The FEMA regulations are more focused on building and site design and construction.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is the result of a collaboration with between the NYC parks and recreation department and the Design trust For Public Space, however the policy does not method community engagement or neighborhood specific efforts.

Is the policy a new approach in flood resilient design?

- No, the policy is supplemental to and already existing common practices in flood resilient park and open space best practices as well as resilient site design best practices.

Policy: Select plants that will improve soil structure

This policy found in the High-Performance Landscape Guidelines for New York City document is a practice underneath the overall policy to create absorptive Landscapes. The policy recommends plans with deep root systems and large amounts of surface or root biomass. These plant and tree types improve soil porosity and enrich soil to add more variation to the plant matrix of the landscape. By using these plan types the soil structure is improved and moisture is absorbed through better infiltration (Design Trust for Public Space and the City of New York, 10)

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Is this policy reflective of recognized best practices?

- Yes, the policy reflects best practices in resilient park and coastal design as well as flood resilient neighborhood design.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, FEMA regulations do not focus on managing stormwater runoff and public space design. The FEMA regulations are more focused on building and site design and construction.

Is the policy working collaboratively with the community and other agencies?

- No, the policy is the result of a collaboration with between the NYC parks and recreation department and the Design trust For Public Space, however the policy does not method community engagement or neighborhood specific efforts.

Is the policy a new approach in flood resilient design?

- No, the policy is supplemental to and already existing common practices in flood resilient park and open space best practices as well as resilient site design best practices.

Resilient Corridor and Street Design

Determine priority spaces within commercial business along corridors and adhere to floodproofing best practices including wet and dry floodproofing, elevation and flood resistant design.

This is a design strategy located in the Resilient Retail report published by the New York Department of City Planning. The design strategy designates floodproofing methods for specific areas in non-residential buildings. Through assessing risk of flooding from high too low for specific rooms in commercial business along corridors flood proofing methods including elevation, wet and dry proofing are recommended for each room. Utilizing this strategy would help maintain business functions, limit costs and improve flood resilience (Coastal Climate Resiliency: Resilient Retail, 16)

Is this policy reflective of recognized best practices?

- Yes, the policy reflects best practices in flood resilient building design utilizing water exclusion and water avoidance concepts.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, FEMA regulations do not have specific requirements to mix dry or wet flood proofing methods within the commercial business or along the street front.

Is the policy working collaboratively with the community and other agencies?

- No, the strategy's intention is to maintain community character and limit burdens on the business owner. The policy does not mention specific community-based recommendations or collaborative partnerships

Is the policy a new approach in flood resilient design?

- Yes, the policy is supplemental to existing practices in flood proofing nonresidential buildings, however it takes a creative approach in enabling more feasibility to implement these practices. In designation specific practices to interior rooms based on risk priority, the policy creatively improves the flood resilience of commercial space and allows for efficient implementation.

Policy: Implement capacity building efforts for businesses along commercial corridors in Rockaway Beach.

The policy is sourced from the Resilient Neighborhoods document for Rockaway Beach and suggests a concerted effort of organized flood resilient capacity building for commercial corridors of Rockaway Beach. The Business Preparedness and Resilience program administered by Small Business Services division implements various community-oriented strategies toward flood resilient improvements. Strategies improve community flood resilience capacity through site resiliency assessments, micro grants for specific resilience improvements and workshops assisting businesses with resilience planning (Coastal Climate Resiliency: Resilient Retail, 16).

Is this policy reflective of recognized best practices?

- Yes, the policy supports best practices in flood resilient corridor design and flood resilient building design. T

Is this policy going above the federal regulation mandated by FEMA?

- Yes, FEMA regulations do not have specific requirements for building flood resilience capacity including community organized initiatives.

Is the policy working collaboratively with the community and other agencies?

- Yes, the strategy is completely focused on community and business-oriented flood resiliency. Additionally, the policy instills collaboration

between business owners, experts in flood resilience and the City of New York.

Is the policy a new approach in flood resilient design?

- Yes, the policy is creative because it is not a focused on physical characteristics of flood resilience. The policy is focused on educating business owners and promoting awareness and the concept of community responsibility and capacity.

Policy: Cloudburst Road Design principles: Bike lanes and rain gardens placed on the side of the road for retention. A green roundabout to retain large volumes of water as well as easing transit.

These design principles intend to facilitate high concentrations of water over short periods of time. Natural stormwater management concepts of infiltration, retention and drainage are realized through implementing green street design elements. These principles integrate vehicle, pedestrian and bike traffic with green infrastructure elements to manage large quantities of water and improve urban connectivity (NYC Environmental Protection, 17).

Is this policy reflective of recognized best practices?

- Yes, the policy supports best practices in flood resilient corridor design and flood resilient building design.

Is this policy going above the federal regulation mandated by FEMA?

- Yes, FEMA regulations do not have specific requirements for building flood resilience street design and public space.

Is the policy working collaboratively with the community and other agencies?

- Yes, the study was conducted on a single neighborhood in queens and collaborated with the City of Copenhagen to implement best practices.

Is the policy a new approach in flood resilient design?

- No, the policy promotes best practices in green street design, however their implementation is commonplace.

Results

The assessment reflects a city determined to become more flood resilient. The City of New York achieved 95% of the points possible for policies meeting Best Practice Standards and 81% for policies exceeding FEMA standards. New York City's flood resilience plans are more comprehensive compared to FEMA's focus on building construction and elevation. New York City broadens this focus to represent urban corridors, coastal resilience, parks and open space and incentive-based policies not found in FEMA requirements. These results show ambition to implement best practices throughout all areas of flood resilient planning and design.

The policies and initiatives assessed in this paper were all published after Hurricane Sandy in 2012. This initial reaction after the storm implements textbook strategies to improve flood resilience. Figure 12 displays the evaluation matrix in detail organizing the assessment through the policy classes.

The strong response is promising and represents a model for coastal flood resilient policy implementation. However, this robust effort is in its infancy and there is much to be improved. The assessment revealed policies lacked creativity, only accumulating 43% of the possible points in this category. Furthermore, the assessment reflected a low score of 62% for the community based and collaborative category. The collaborative and community based, and creativity categories were weighted less than the other categories for two reasons; not all flood resilient policies are intended to be collaborative and community oriented and creativity is not always an indicator of a good policy.

Class	NYC-Queens Policy	Policy Grade Scale (= 5 pts, = 15 pts, = 30 pts, = 50 pts)	Documents Sourced
Resilient Zoning	Study and implement zoning changes to encourage retrofits of existing buildings and construction of new resilient buildings in the 100-year floodplain. Planting requirements single family zoning: Plantings including trees are required to be three feet high and three feet in depth the length of planting areas should meet 60% of the lot width. Buildings in the floodplain cannot have sub-grade spaces, such as basements or cellars. Ground-floor use is limited to parking, storage or access in residential buildings, since this space has to be wet flood proofed.		
Coastal Protection	Evaluate soft infrastructure as flood protection and study innovative coastal protection techniques. In waterfront areas accessible to the public, require wind and salt-tolerant trees and regular tree pruning. Encourage private owners to follow the same practices. (BRTF) Plan for Adaptive Stewardship of Vacant City-Owned Properties to be used for coastal protection.		
Incentive Based Policy	Dry-flood-proofed commercial ground-floor space can be exempted from the amount of floor area allowed and an equivalent amount of space can be constructed elsewhere on site. Encourage existing buildings in the 100-year floodplain to adopt flood resiliency measures through an incentive program and targeted mandate. The development of incentive based programs and the use of bidding scoring systems that recognize improved contractor education and training need to be carefully vetted prior to implementation to ensure legal compliance.		
Building Elevation Standards	Flood Resistant Construction Elevation (FRCE) required by the City of New York, mandates an additional one to three feet above the latest FEMA Base Flood Elevation requirement. Adjust ground-floor use requirements to maintain street-activating uses where possible in cases where ground floors are substantially above adjacent grade. Establish a sea level rise-adjusted Design Flood Elevation.		
Flood Proof Construction Standards	Dry and wet flood-proofing best practices utilized for residential and non-residential uses. Capture storm-water to Prevent Flooding Design buildings to resist hydrostatic forces from higher design flood elevations.		
Resilient Park and Open Space Planning	Manage storm-water adjacent to restoration areas to prevent any additional storm-water runoff to these areas. Position absorptive landscapes deliberately maximizing flood control potential. Select plants that will improve soil structure.		
Resilient Corridor and Street Design	Determine priority spaces within commercial businesses along corridors; adhere to flood-proofing best practices including wet and dry flood-proofing, elevation and flood resistant design Implement capacity building efforts for businesses along commercial corridors in Rockaway Beach. Cloudburst road design: Rain gardens on roads edge for retention. A green roundabout to retain large volumes of water.		

Figure 12

FLOOD PROOF CONSTRUCTION STANDARDS

C

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	150
Exceeds requirements under FEMA	60
Collaborative and Community Based	0
Creativity	5
TOTAL	215
GRADE	72%

Flood Proof Construction Evaluation Result (Figure 5.2)

The Flood Proof Construction standards class scored the lowest amount of points with 215 out of 300. No policy in this class met the criteria for collaborative and community based. All the policies found in this class had a city-wide target rather than specific neighborhoods. Flood proof construction is a significantly standardized class as various building codes seek to meet FEMA regulations which reference the American Society of Civil Engineers Flood Resistant Design and Construction manual. Although New York City has exceeded FEMA requirements in two of the three policies reviewed for this class.

Figure 13

INCENTIVE BASED POLICY

C

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	100
Exceeds requirements under FEMA	90
Collaborative and Community Based	45
Creativity	0
TOTAL	235
GRADE	78%

The Incentive-based class scored well in the collaborative and community-based category but failed to capture points in creativity. In this circumstance collaboration and community engagement did not yield creative results; although do these policies need to be creative to be successful? The overall intention of this policy was to enable residents and business owners to retrofit their properties to become more flood resilient. This policy class scored well in policies that exceed FEMA requirements and meets its goal of improving flood resilience.

Figure 14

RESILIENT PARK AND OPEN SPACE STANDARDS

B

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	150
Exceeds requirements under FEMA	90
Collaborative and Community Based	0
Creativity	0
TOTAL	240
GRADE	80%

Figure 15

The Resilient Park and Open Space Design class scored full points for established best practices and practices exceeding requirements under FEMA. None of the polices were community based or collaborative in a manner which neighborhood residents and business owners participated in the process. This is especially important in designing park and open space as the residents, business owners and patrons were the users of the space. I believe missing this category in this policy class is underperforming.

RESILIENT ZONING

B

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	150
Exceeds requirements under FEMA	60
Collaborative and Community Based	30
Creativity	5
TOTAL	245
GRADE	82%

Figure 16

The Resilient Zoning policy class scored 245 points out of a possible 300 exceeding FEMA requirements in two out of three policies and achieving one creative policy. The policies reviewed reflect consistent collaboration and community focused policy and practices which meet established best practices in overlay zoning and building design.

BUILDING ELEVATION STANDARDS

B

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	150
Exceeds requirements under FEMA	60
Collaborative and Community Based	45
Creativity	15
TOTAL	265
GRADE	88%

The Building Elevation Standards policy class received full points for incorporating established best practices and community based/ collaborative policy. The best practices are customary for flood resilient building elevation standards, however maintaining collaboration with outside agencies ensuring flood resilience is critical. Two polices in this class were considered creative revealing a unique approach to solve urban design issues caused by flood resilient design.

Figure 17

COASTAL PROTECTION

A

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	150
Exceeds requirements under FEMA	60
Collaborative and Community Based	45
Creativity	15
TOTAL	270
GRADE	90%

The Coastal Protection policy class scored well in all categories only missing one policy which did not exceed FEMA standards, all other categories received full credit. All policies were considered creative which promoted new approaches to coastal protection. The focus on coastal protection is abundantly clear in how these polices incorporate best practices, interweave communities and collaborate with third parties and exceed FEMA regulations. A strong focus on new approaches that incorporate unique resilience measures contributed to this policy classes A rating.

Figure 18

RESILIENT CORRIDOR AND STREET DESIGN

A

POLICY GRADE SCALE	Pts
Incorporates Established Best Practices	150
Exceeds requirements under FEMA	90
Collaborative and Community Based	30
Creativity	10
TOTAL	280
GRADE	93%

The Resilient Corridor and Street design policy class nearly achieved full credit in all categories missing only one creative policy and one collaborative/community-based policy. These policies show a strong focus on the public realm and the protection of small businesses. These neighborhood street corridors are essential arteries in the community that stand out as landmark streets for tourists and points of pride for locals. Places like Rockaway Beach and Old Howard Beach have promoted policies in resilient corridor and street design, showing a commitment to protecting the neighborhoods social and economic infrastructure.

Figure 19

Conclusion and Recommendations

Cities are starting to invest heavily in resilience, realizing value in balancing urban development with the natural systems people depend upon. While the science of climate change reflects projected sea level rise, higher levels of precipitation and stronger hurricanes, these impacts were not apparent 10 or 15 years ago. Within this time urban areas have interfaced with these projected impacts sparking the urgency to build for climate change. This policy review is a chance to measure how New York City is building for a more extreme climate and sets a blueprint for other coastal cities could utilize.

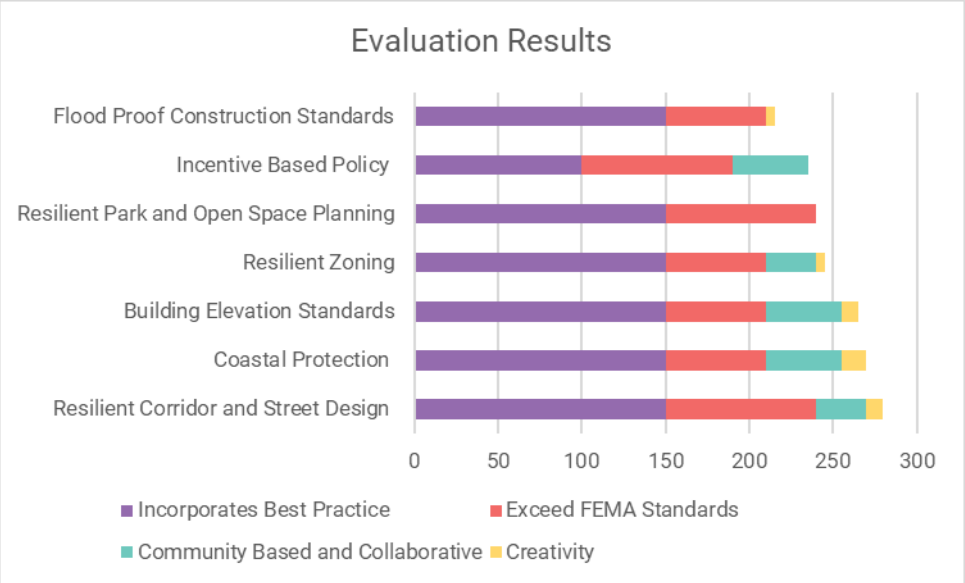

Figure 20

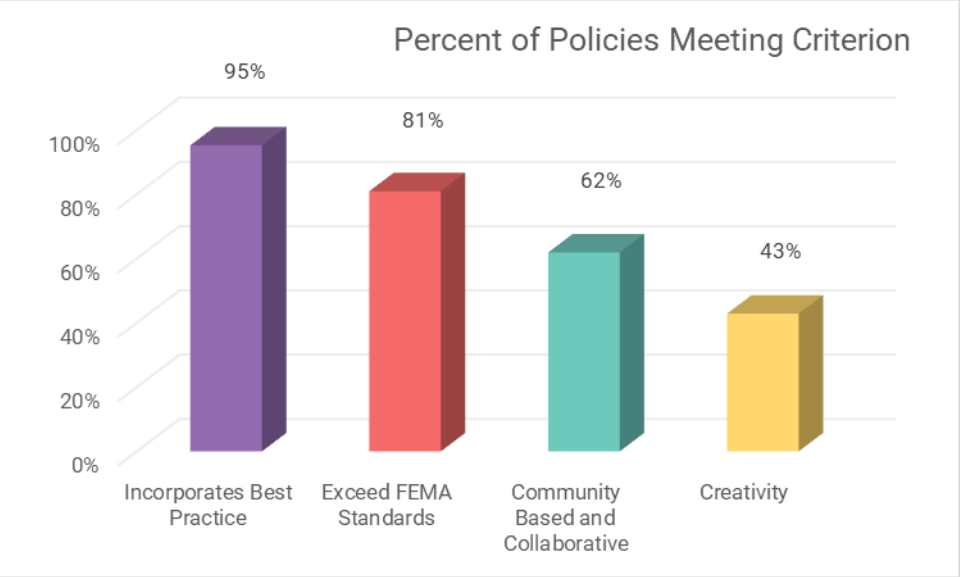

Figure 21

The New York City Flood Resilience Policy analysis shows an acute effort to utilize best practices. Best practices were evenly distributed throughout the policy classes only missing one grade. The City made a concerted effort to exceed FEMA standards achieving this grade in at least one policy in all policy classes.

This shows a comprehensive intention understanding the FEMA regulations do not represent the highest standard of flood resilience.

The least weighted categories had a more scattered grading applied as some policies did not have a goal where creativity, collaboration and community orientation were prioritized. The lack of applicability in these less weighted grade criteria are indicative of a young policy movement that is processing how to best integrate flood resilient design principles comprehensively in cities and neighborhoods.

Recommendations & Rationale:

1. Integrate community-based policies that promote collaboration and resilient design.
    a. Rationale: Community based policies focus on a small-scale project, allowing for smaller groups of stakeholders to collaborate on a successful path forward. Neighborhood specific strategies typically have smoother implementation processes because the stakeholders are involved in the planning process and are deeply incentivized by the success of the improvements. While New York City has plenty of community-based plans and policies, there is room for innovation and creativity to integrate further collaboration. The neighborhood resilience plan for Rockaway Beach, Old Howard Beach and Broad Channel is an example of a community-based plan pursuing community specific initiatives. NYC should integrate more neighborhood-based resilience planning into its overall planning efforts.

2. Produce creative incentive-based policies enabling feasible flood resilient design.
    a. Rationale: Incentive based policies are imperative to improving the effectiveness of flood resilience design. Often, a policy requires a business owner, homeowner or municipalities to invest large sums of money into the improvement. While individual resilient design projects benefit the single investor/owner, it also provides a common benefit for the rest of the area. The less flooding on a single lot due to a single resilience investment would also reduce flooding on adjacent lots. Because of this shared benefit, incentive-based policy incentives are necessary. Pushing incentive-based policies further than a single user of the policy may be an option to expand creativity. An example could be incentive based policies with multiple participants in a focused area like a neighborhood street or business corridor where all residents or business owners on the street must buy in to receive the incentive.

3. Integrate resilient subdivision ordinances throughout the 100-year floodplain mandating flood resilient construction that surpasses FEMA requirements.
    a. Rationale: New York City is a world class city possessing an extreme amount of value to its residents and the rest of the world as a global economic center. Protecting this global asset is paramount to ensuring stability in more places

than just New York City. Additionally, the 100-year floodplain in New York City is especially vulnerable to the effects of climate change. The mid-Atlantic region is expected to receive above average sea level rise compared to the rest of the globe increasing the impacts of storm surge and tidal flooding. Furthermore, the northeast mid Atlantic is along a common path for Atlantic based hurricanes which are becoming more intense. Requiring additional protective measures to property, people and general welfare is an appropriate measure. Developers of Arverne by the Sea, a residential mixed-use subdivision in Queens, were forced to construct at flood resilience standards above FEMA requirements and they were one of a few coastal developments that escaped hurricane Sandy with minimal damage.

4. Expand 100-year floodplain FEMA construction standards to the 500-year flood plain.
    a. Rationale: Hurricane Sandy flooded an area more than one half the size of the 100-year flood plain and Sandy was a 260-year storm. While not a 500-year storm, Sandy still flooded areas within the 500-year flood plain. Expanding FEMA required construction standards of the 100-year floodplain to the 500-year floodplain can protect property and lives in the event of severe flooding.

5. Protect existing natural infrastructure from development deterring future flood risk due to development.
    a. Rationale: New York City has several areas of natural wetland and tidal marshes which act as natural defenses against coastal flooding. Often, these lands are viewed as underutilized and are sought for development. Natural coastal wetlands, marshes and beach barriers are critical in protecting the built environment form tidal flooding and storm surge, protecting these natural assets could limit the need for obtrusive engineered protective measures like levees and bulkheads which degrade the natural environment and can fail.

6. Create a team in the city to monitor policy implementation and effectiveness focusing on how to improve existing policy.
    a. Rationale: This policy recommendation accounts for policy performance. A team led by the Chief Resilience Officer to measure a policies performance and

compare this with the policies goals when it was adopted. This type of accountability will lead to a policy framework that is highly adaptive, showing that policy can change or improve when conditions change or if the policy has been ineffective at attaining its initial goals. The overall monitoring process should happen twice a year at minimum.

7. Integrate a grey infrastructure flood resilience plan that transforms existing grey infrastructure to flood resilient grey infrastructure.
    a. Rationale: This recommendation is intended to focus on flood resilient strategies for existing grey infrastructures which cannot be transformed into green infrastructure. A public works led plan could lead to significant improvements enhancing flood resilience by for example, using porous hardscape materials instead of concrete

8. Create a program that utilizes an additional property tax payment to fund flood resilient retrofits in residential and nonresidential uses.
    a. Rationale: This policy recommendation follows an existing framework of Property Assessed Clean Energy (PACE). The PACE framework allows for homeowners to invest in clean energy for their home through an additional payment on their property taxes for a period. Applying this structure to flood resilient retrofits could represent an opportunity for homeowners to protect their property without spending high initial costs for resilient retrofits.

9. Establish a policy requiring collaboration with New York City's Panel on Climate Change for any flood resilient policy or initiative.
    a. Rationale: New York City's Panel on Climate Change was formed in 2008 as a local panel of climate and data scientists set to monitor and project climate data while recommending strategies based on this research. As the City of New York implements flood resilience policies, this policy suggests an expansion in the role of NYPCC through an approval process for adequately scaled resilience initiatives and projects. By expanding the NYPCC's role this way, there is direct oversight of implementation measures based on the current science and data.

10. Produce creative policies through extensive collaboration with internal and external references.
    a. Rationale: This policy is reinforcing how a resilience is a community effort and through this collaborative effort creative policies may emerge. The collaboration with universities through student or faculty projects could help educate local youth and promote new ideas for expanding policy in flood resilience. Limiting this collaboration would hurt the overall perspective of the adopted policy. This policy suggests implementing a forum for collaboration with institutional facilities to enhance creativity and education.

The recommendations are targeted to expand New York City's collaboration with communities and with external resources. The intended outcome of these policies is to cultivate creativity with new approaches to flood resilient design. The policies reviewed in this paper are a result of a newly formed framework for resilient design that begins with established best practices and mandated standards. As proven best practices are implemented, space for innovation and increased collaboration must follow to push standards past current targets.

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